MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2017/2018

EME4026 – TRIBOLOGY

(ME)

13 MARCH 2018
9.00 a.m. – 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 4 pages with 4 Questions only.

2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1:

(a) List the four factors that determine the relative contribution of ploughing friction to the total friction between two sliding surfaces.

[4 marks]

(b) A hard metal spherical ball of 20 mm diameter slid across a soft metal surface, produces a groove of 4 mm width. For a measured coefficient of friction of 0.8, **calculate** the adhesive contribution to the coefficient of friction (μ_a).
Assume the dominant sources of friction are adhesion and ploughing and these are additive.

[6 marks]

(c) Derive expression for ploughing friction coefficient of a hard rigid *spherical asperity* sliding over a softer flat surface with the aid of neat schematic sketches.

[15 marks]

Question 2:

(a) Sketch the graph of erosive wear rate against angle of attack for both ductile & brittle materials.

[6 marks]

(b) Why is a material's purity so important in the control of contact fatigue wear or delamination wear?

[4 marks]

(c) A square metal pin with a dimension of 2.5 × 2.5 mm and with hardness, H of 0.5 GPa and density, ρ of 6.5 Mg/m^3 slides against a surface at a constant velocity, V of 0.4 m/s and apparent pressure, p_a of 0.04 GPa. The mass loss of the square pin is 80 mg in 4 hours.

(i) Determine the adhesive wear coefficient for the square metal pin. **[10 marks]**

(ii) Estimate the mass loss (mg) for the square metal pin slides in 10 hours.

[5 marks]

Continued.....

Question 3:

(a) In general, there are three different types of lubrication regime, namely full-film, mixed and boundary. Explain the difference of the three lubrication regime with schematic diagrams.

[9 marks]

(b) The full Reynolds Equation in three-dimensional is given as:

$$\frac{\partial}{\partial x}\left(\frac{h^3}{\eta}\frac{\partial p}{\partial x}\right)+\frac{\partial}{\partial y}\left(\frac{h^3}{\eta}\frac{\partial p}{\partial y}\right)=6\left(U\frac{\partial h}{\partial x}+V\frac{\partial h}{\partial y}\right)+12(w_h-w_o)$$

i. Simplify this equation to one-dimensional form for infinitely long bearing; state the assumptions made for this simplification.

[10 marks]

ii. Derive the final form of the one-dimensional Reynolds equation for the long bearing approximation.

[6 marks]

Continued.....

Question 4:

(a) A *short hydrodynamic bearing* is designed to operate with an eccentricity ratio, ε of 0.75. The journal speed is 1450 rpm and its diameter, D is 55 mm. The journal is supported by a short hydrodynamic journal bearing of length $L/D = 0.5$, and clearance ratio $C/R = 1\times10^{-3}$. The radial load on the bearing is 2500 N. Assume that infinitely-short-bearing theory applies to this bearing, and determine the following:

i. The Sommerfeld number, **[5 marks]**

ii. Minimum viscosity of the lubricant for operating at $\varepsilon = 0.75$, **[5 marks]**

iii. Lubricant flow rate at the inlet of the bearing, **[3 marks]**

iv. Figure Q4 shows a viscosity – temperature chart. Select a lubricant (SAE Oil) from the given chart based on answer of (ii) if the average bearing operating temperature is 85 °C. **[2 marks]**

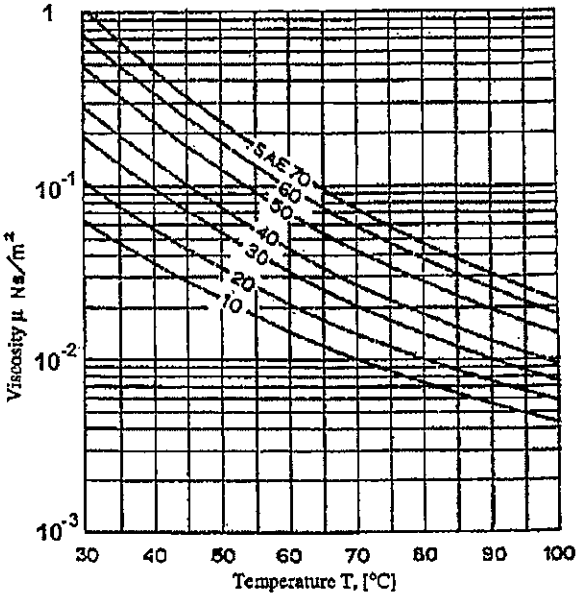

Figure Q4

(b) We need to consider both economy & environment factor when we want to reduce bearing failure. Give one example when you will have contradict decision based on economy and environment point of views.

[6 marks]

(c) There is a wide range of bearing materials to select from – metals, plastics, and composite materials, however there is no one ideal bearing material for all cases. Why? **[4 marks]**

End of Page